Aug 17, 2002 (Ver.2.0)

Eastern System and Semiconductor Design

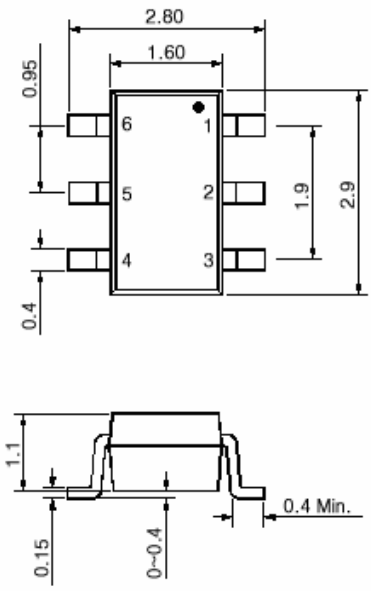
EM01
1-CH Capacitive Touch Sensor

General Description

The EM01 touch sensor designed specifically for touch controls. It provides stable sensing under a wide variety of changing conditions and projects a sense field through almost any dielectric. It is designed specifically for human interfaces, like control panels, application lighting controls or anywhere a mechanical switch or button may be found.

General Feature

- 1-Channel Capacitive Sensor
- Projects a 'touch button' through any dielectric
- TTL Output
- Internal output holding timer
- Prevent abnormal operation during VDD on transient time



SOT-26 Small Package (unit:mm)

Application

- Fluid level sensing
- Switch replacement
- Human presence detection
- Appliance control Switch (TV/Monitor/Telephone etc)
- Toys & interactive games
- Lighting controls (on/off)
- Membrane switch replacement
- Sealed control panels, keypads

Pin Description

PIN NO	PIN NAME	TYPE	Description	PIN NO	PIN NAME	TYPE	Description
1	Sen_cap	AI	Sensor input	4	R_bias	AI	Resistor of Holding & Bias
2	GND	-	Ground	5	VDD	-	Supply
3	Ref_cap	AI	Sensitive adjustment & ref Cap	6	OUTPUT	DOI	TTL Output

Absolute Maximum Rating (Note 2)

Battery supply voltage	5.2V
Maximum voltage on any pin	VDD+0.3
Maximum current on any PAD to avoid latch-up	100mA
Power Dissipation	3mW
Storage Temperature	-50 ~ 150℃
Operating Temperature	-20 ~ 75℃
Junction Temperature	150℃
ESD protection	2000V

Operation conditions (Note 1, 2)

Characteristics	Symbol	Test Condition	Min	Typ	Max	Units
Supply Voltage	V_{DD}	-	3	-	5.2	V
Current consumption in disable mode	I_disa	All blocks disable	-	-	900	uA
Power dissipation	Pd	-20 ~ 75℃	-	-	20	mW
Operating Temperature	T_{opr}		-20	-	75	℃

Electrical Characteristics (Note 1,2)

T_A = 25℃ (P_on_rst pin must connect vdd) R_bias=75kΩ

Characteristics	Symbol	Test Condition	Min	Typ	Max	Units
Current consumption	I_{DD_On}	Osc_bias_adj=75kΩ	-	800	900	uA
Output drive current	Io	Sensor (Sin) touched	2.0	3.0	4.0	mA
Output voltage Ⅰ	V_H	Sensor (Sin) touched	VDD-0.5	VDD	VDD+0.5	V
Output voltage Ⅱ	V_L	Sensor (Sin) non-touched		VSS	VSS+0.5	V
R_bias range	R_bias	30kΩ≤ R_bias ≤200kΩ	2.5	-	75	uA
Output hold time	T_hold	30 kΩ ≤ R_bias ≤ 200 kΩ	-	-	100	ms
Sensible capacitance difference	ΔC1	Touch through any dielectric R_bias = 75 kΩ, Ref_cap = 4pF	0.5	-	-	pF
Reference capacitance range	C_ref	Touch through any dielectric Osc_bias_adj = 75 kΩ	2.5		10	pF
		Electrode touch Osc_bias_adj=75 kΩ	10	-	30	pF
Channel error	Δf		-	-	1	kHz

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance

Pin Function

Sen_cap

Sensor Touch input pin, it is connected with touch pad.

Ref_cap

Reference time generation capacitance which is compared to the capacitance of sen_cap. Ref_cap should be selected higher value than Sen_cap, when Sen_cap(touch pad) is not touched. If touch pad is touched, Sen_cap should be higher then Cref.

R_Bias

Timer bias control pin which is related in Sen_cap, Ref_cap.
Also Output holding time setting pin, for protecting of malfunction of circuit from noise. As a value of this resistor, internal circuit decide time delay between input and output.
Using 30kohm ~ 150kohm resistor, it control time with Ref_cap capacitor. In direct touch, 30kHz ~ 100kHz is recommended

Touch application(note 3)

R_ref = 75kΩ, Cref_nt(Cref_t) ≤ 15pF
(delay time : 50ms)
R_ref = 45kΩ, Cref_nt(Cref_t) = 15 ~ 20pF
(delay time : 100ms)
R_ref = 20kΩ, Cref_nt(Cref_t) > 20pF
(delay time : 120ms)

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Sensitivity Adjust

Sense Capacitance

Specially in case of non-touch application, you have to think about variation of sensing capacitance value. Defend on dielectric materials, thickness, The capacitance of touch PAD has a deviation. After you consider it enough, you have to decide reference capacitance value.

Ref_Cap > Sen_Cap(Touch PAD) before touch

Reference Capacitance

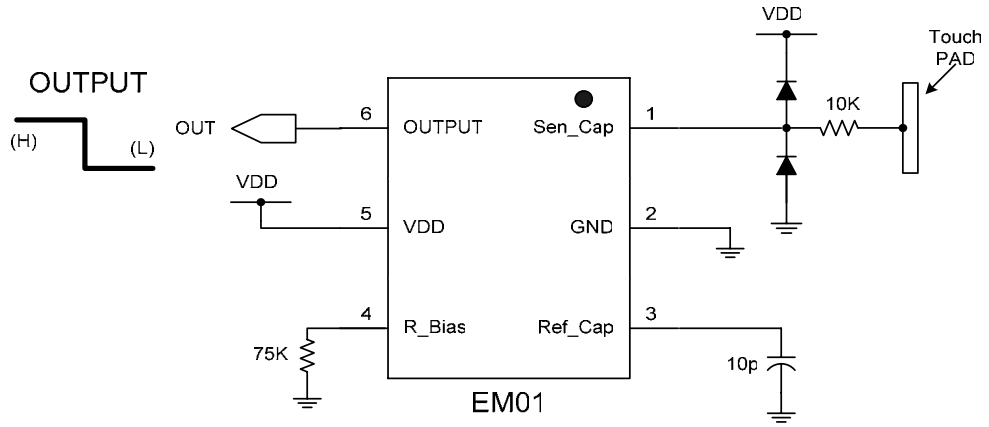
Initial reference capacitor value may can decide to +0.5pF ~ 1pF higher then Touch PAD capacitance. From the experiment in lab, when we use 1 ~ 3t dielectric thickness, the variation of touched capacitance is around 0.3pF ~ 1pF

Principal

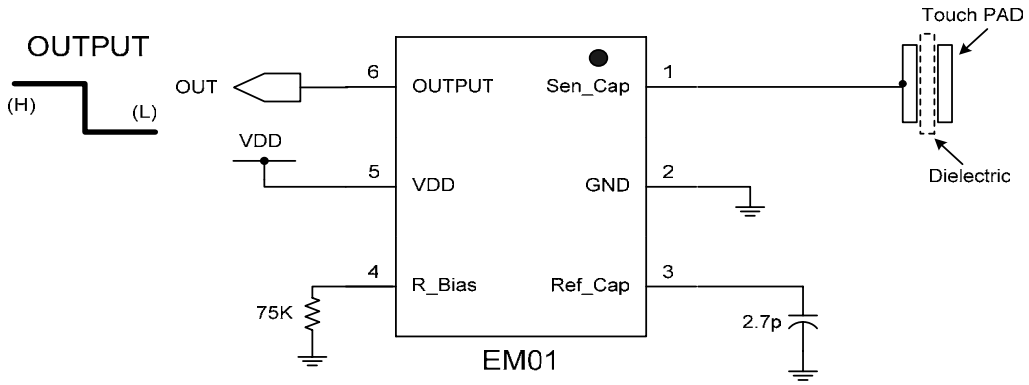
The EM01 touch sensor designed specifically for touch controls. It provides sable sensing under a wide variety of changing conditions. It will project a sense field through almost any dielectric. It is designed specifically for human interfaces, like control panels, application lighting controls or anywhere a mechanical switch or button may be found.
Like all capacitance sensor, the EM01 relies on Kirchoff's Current Law to detect the change in capacitance of the electrode. This law as applied to capacitive sensing requires that the sensor's field current must complete a loop, returning back to its source in order for capacitance to be sensed.
Although most designers relate to Kirchoff's law with regard to hardwired circuits, it applies equally to capacitive field flows. By implication it requires that the signal ground and the target object must both be coupled together in some manner for a capacitive sensor to operate properly.
Note that there is no need to provide actual hardwired ground connections; capacitive coupling to ground is always sufficient, even if the coupling might seem very tenuous.
For example, powering the sensor via an isolated transformer will provide ample ground coupling, since there is capacitance between the winding and/or the transformer core, and from the power wiring itself directly to local earth Even when battery powered, just the physical size of the PCB and the object into which the electronics is embedded will generally be enough to couple a few picofarads back to local earth.
When detecting human contact, grounding of the person is never required. the human body naturally has several hundred picofarads of 'free space' capacitance to the local environment which is more than two orders of magnitude greater than that required to create a return path to the EM01 via earth.

Application Notes

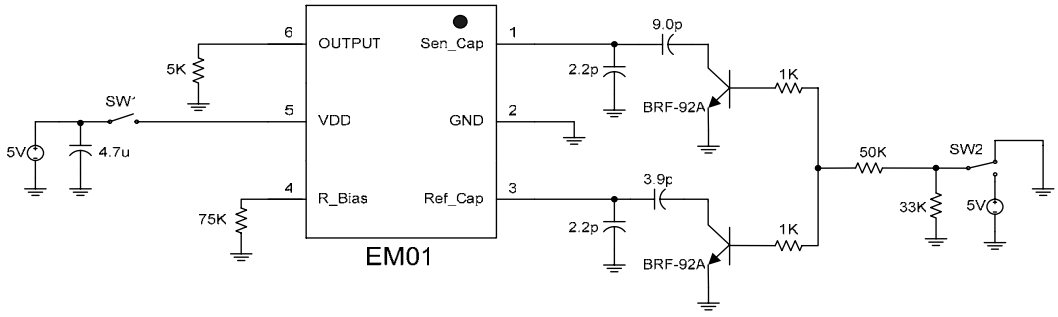
Case A : Electrode touch



Case B : Electrode non-touch



Test Circuit



PCB Layout recommendation

Common drawing rule

1. PCB pattern from sense Pin to touch point have to draw equal pattern length and width respectively.
   (Include protection diode pattern)
   Because PCB pattern parasitic capacitance may cause abnormal operation.

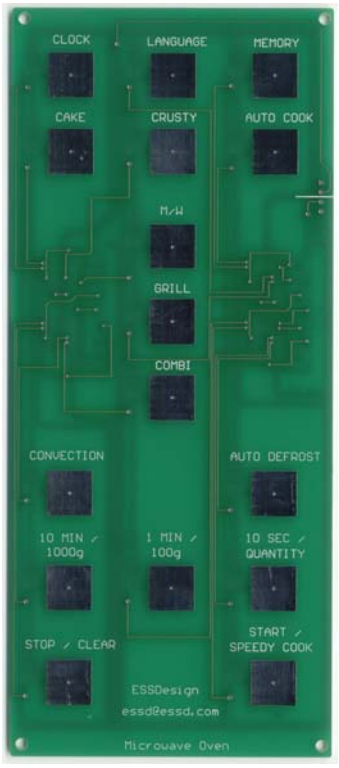
2. The touch PAD have to make use conduct material.

3. Each signal line (Sense Pin line) have to separate as possible as far to avoid interference.

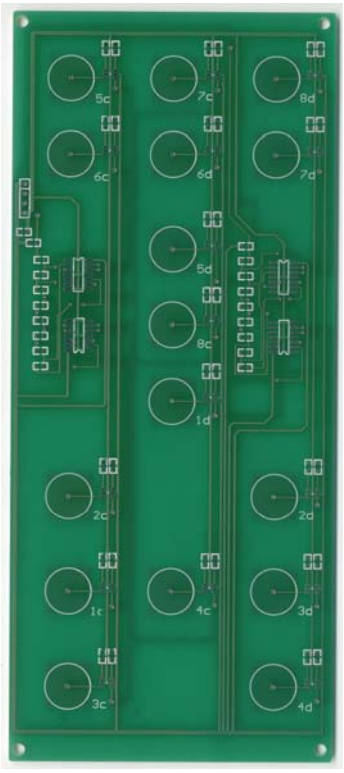
4. From touch PAD pattern to other patterns have to have distance around 2mm.

5. You have to connect touch panel GND to chassis GND.

Example A : Microwave oven control panel



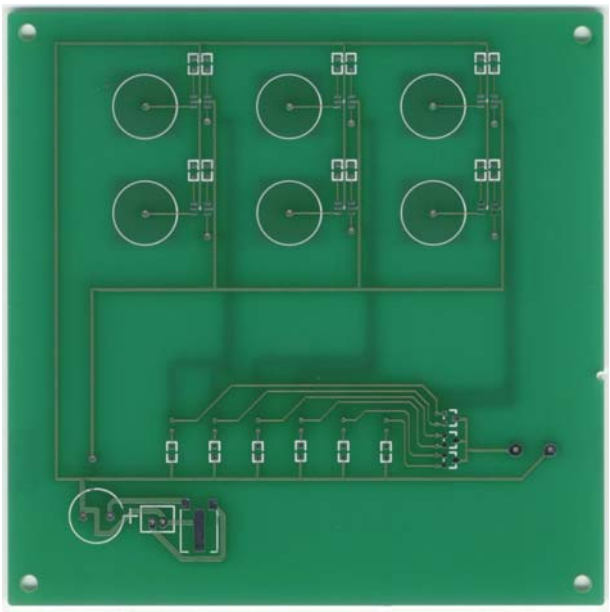
Front Side



Back Side(touch side)

Example B : EM01 DEMO Board

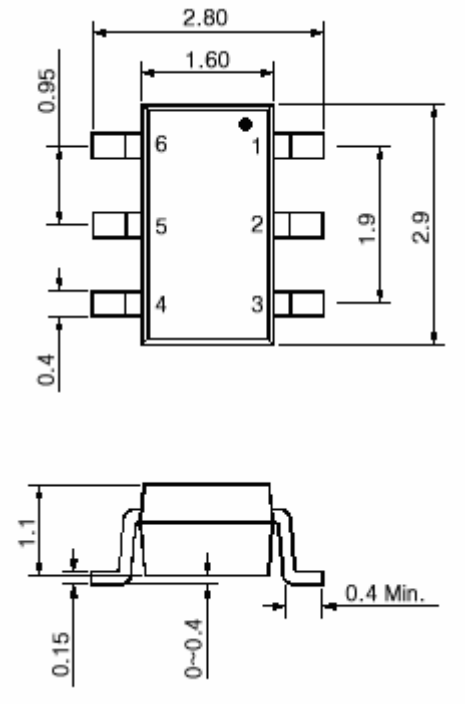
Front side(Touch side)



Back side

Physical Dimensions

millimeters unless otherwise noted



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